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IN-SITU CHEMICAL IMAGER

Living organisms and their traces are morphologically and chemically differentiated from background. On earth, biological organisms have unique structures and internal compartments that provide morphological signatures for life. In addition, living organisms use some elements preferentially, leading to chemical differentiation relative to the non-living background. These biosignatures are chemically and functionally driven and are expected to apply to non-terrestrial life as well. This makes high-resolution chemical imaging high priority for an astrobiological suite of instruments.

In our instrument spatially resolved chemical imaging is achieved by combining a fiber optic scanning probe microscope, SPM with laser induced breakdown spectroscopy, LIBS, in a single instrument, Chemical Imager. Elemental composition of surfaces can be mapped and correlated with topographical data. The experiment is conducted in ambient conditions with minimal sample preparation. In a typical experiment surface topography is analyzed by scanning a sharp fiber optic probe across the sample using shear force feedback. The probe is then positioned over a feature of interest and pulsed radiation is delivered to the surface using a nitrogen laser. The pulse vaporizes material from the surface and generates a localized plasma plume. Optical emission from the plume is analyzed with a compact UV/VIS spectrometer. Ablation crater size is controlled by the amount of laser power coupled into the probe. Sampling areas with sub-micron dimensions are achieved by using reduced laser power.

The instrument performance is being characterized currently with a wide variety of samples ranging from ancient fossils to Mars soil analogs to industrial semiconductor integrated circuits. We will present results from experiments designed to examine terrestrial analogs on microfossils to demonstrate the ability to differentiate microfossils from pseudofossils.

The attractive features of this analytical methodology include minimal to no sample preparation, capability to perform studies in ambient environment, low cost, and adaptability to portable design. Many pieces of the chemical imaging hardware have already been developed and flight qualified. Mars Environmental Compatibility Assessment (MECA) payload, originally scheduled for Mars '01 Lander, included an Atomic Force Microscope (AFM) for topography analysis of fine dust particles. The In situ Chemical Imager and AFM share common electronics, micropositioning hardware, and sample translation mechanism. The difference is in the type of the topography probe, and in the presence of LIBS chemical analysis system.